STATION CIRCULAR 118 MAY 1936

Fiber Flax in Oregon

By
BRITTAIN B. ROBINSON

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Agricultural Experiment Station
Oregon State Agricultural College
CORVALLIS

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BRITTAIN B. ROBINSON, Associate Plant Breeder,
Division of Cotton and Other Fiber Crops and Diseases,
Bureau of Plant Industry

INTRODUCTION

DURING the past 10 years methods used in the processing of fiber flax in Oregon have undergone a complete transformation by the introduction of the most successful inventions in flax machinery. These advancements have placed fiber flax in a position to offer possibilities of becoming a permanent paying crop for the Oregon farmer.

Culture practices have passed through experimental stages and knowledge concerning the best for fiber flax production in the Willamette Valley has been largely determined. It is the purpose of this bulletin to outline some of the practices that have met with the best success under Willamette Valley conditions and a careful study and application of these recommendations likely will enhance the farmer's success in flax production.

FLAX IS A CONTRACT CROP

A farmer is taking a risk if he attempts to grow fiber flax without first obtaining a contract with a reliable organization that guarantees a market for the crop after it is harvested. Farmers who plan to grow this crop should obtain their contracts as early as possible during the previous winter months so they can make definite plans for the crop. Growers who are not acquainted with the names and addresses of flax companies that purchase flax and also furnish the fiber flax seed for planting may obtain the names and addresses by writing to the Oregon Agricultural Experiment Station at Corvallis.

Type of contract. In the common type of contract used in Oregon the flax company agrees to furnish clean fiber flax seed. The farmer pays for the seed when the crop is marketed and in case of a crop failure the farmer is required to pay a definite price for the seed used. The flax company agrees to purchase the unthreshed flax at a definite price per ton delivered at the flax mill after harvesting and curing. The company also agrees to inspect the land before planting, approve it for flax growing, and inspect the crop before harvest in order to grade it as to quality.

The farmer agrees to plant the flax upon definitely approved soil before a specified date in the spring. These provisions tend to insure early planting on good land and are an assurance to both parties as to the success of the crop. The farmer further agrees to deliver the flax straw, cured, and tied in a specified manner, to a definite flax mill plant.

*Fiber flax investigations are carried on under a cooperative agreement between the Bureau of Plant Industry, Division of Cotton and Other Fiber Crops and Diseases, United State Department of Agriculture, and the Oregon Agricultural Experiment Station, Corvallis, Oregon.

The grower should be paid in full upon the delivery of his crop or within a reasonable time thereafter. Usually most contracts contain a clause that permits dockage for weeds and foreign material. A statement generally is included that allows the flax company to nullify its agreement to purchase the straw if it is so short that it is unadapted for fiber purposes or if it contains so many weeds that it would be impossible to work the crop economically.

Distribution in the state. Because of climatic and soil relations fiber flax is particularly well adapted to the Willamette Valley in Oregon. The crop probably would grow well in some sections along the coast and in some portions of the Rogue and Umpqua River Valleys, although it is likely flax is not adapted to most counties east of the Cascade mountain range because of the dry climate. Along the Pacific Coast fiber flax might grow well, but because of limited soil areas for its culture and unfavorable conditions for retting and drying straw after harvest, it is unlikely that this region will develop as an important fiber flax growing area.

In the Rogue and Umpqua River Valleys the culture would depend entirely upon whether enough acreage of good soil types could be obtained in a vicinity to keep one mill in operation. Fiber flax has been grown with success in the Willamette Valley but its culture on a commercial basis has been largely confined to land near the flax mills located at Salem. Cost of transporting flax straw from remote regions in the Willamette Valley to Salem has been too great to be profitable. If more flax mills are constructed in different parts of the Willamette Valley it is believed that the flax growing area could be greatly expanded because of the lower cost of transporting the flax from the farmer's field to the flax mill. Under present conditions little flax is grown more than 30 miles from a flax plant.

REQUIREMENTS OF FLAX PRODUCTION

Climate is important. Climatic relations of the Willamette Valley of Oregon are adapted to the culture of fiber flax as well as to the processing of the straw and manufacturing of the fiber. For the production of the best quality of fiber, the growing season for fiber flax should be cool and moist. These conditions exist in the Willamette Valley if fiber flax is planted before April 15. When planted before the middle of April the flax will grow better because it is aided by the late spring rains, maturing with the beginning of the dry summer period the latter part of June. The dry weather aids in the maturing of the fiber flax crop and harvest usually occurs during the first part of July. A golden color is produced in the mature flax, resulting in a light colored fiber that is considered more favorably by spinners than the dark colored fiber. Further, the dry summer period of four or five months in the Willamette Valley is helpful to the retting (soaking) and drying processes that take place at a flax mill.

The moist winter months of the Willamette Valley are beneficial for the processing or scutching (separating the wood from the fiber) because humidity prevents the fiber from becoming brittle and breaking into tow (short and broken fibers) when being scutched. During this period the high humidity is also beneficial in spinning the flax fiber, all plant fibers spinning better under humid conditions.

Correct soil is essential. The selection of a soil type or series adapted to fiber flax production is a vital factor in the successful production of a profitable crop. Hill soils generally are not adapted to fiber flax, and the flax companies usually do not contract these acreages because experience has indicated that the crop seldom is better than average. Generally these hill soils lack fertility and are shallow, drying out too early in the summer to permit a full growth of the flax plant. Other types of soil in the Willamette Valley that are not especially suited for fiber flax culture are those which because of their texture and structure lack drainage, thus preventing working in the early spring for early planting. Such types commonly called "white lands" of the Dayton series and the Wapato river bottom soils come under this classification. Only occasionally when conditions are right to allow early working have these soils produced profitable crops.

The acreage of the three principal soil series in the Willamette Valley adapted to fiber flax culture is as follows:

Chehalis	218,715 acres
Willamette	351,680 acres
Amity	277,568 acres

The soils of the Amity series sometimes are not adapted unless tiled and well managed to maintain their fertility.

These figures show that there is an exceptionally large area of land in the Willamette Valley that can be utilized for fiber flax if conditions ever warrant its production. The Chehalis soil series is a group of river bottom soils that permits early working in the spring months. Usually hops are planted on this soil. The Willamette and Amity soils are commonly called the "second bench land" soils. These soils usually produce good results with fiber flax when fertile and free of weeds. The soil should be rich enough to grow a good crop of grain or clover, thus insuring a good length of straw that will mean additional tonnage of flax as well as an additional price per ton because of a better grade.

It is important that weedy soils be avoided when producing fiber flax because the expense of removing weeds undoubtedly will make the crop unprofitable. The principal weeds that are troublesome in fiber flax are wild oats, French pink, dog fennel, mustard, fox tail, thistles, and ferns.

Three to five year rotation best. Fiber flax should not be grown on a field more frequently than once in three to five years. If flax is grown several years in succession upon the same field, root rot and other diseases may develop. The best way to combat these diseases is to rotate the crop and sow only seed that is highly resistant to such diseases. The flax seed that is furnished by a flax mill usually is the best seed that is available. Flax is not hard on the soil as it actually removes less fertility from each acre than a good crop of grain.

It is surprising to learn how few flax farmers actually have a definite rotation on their farm. Undoubtedly it would be a good farm practice for the farmer to study this question more thoroughly and as nearly as possible plan a definite rotation for his crops. Results in the Willamette Valley (Table 1) have shown that flax does much better after corn and clover crops than when grown after cereals.

Table 1. YIELD OF UNTHRESHED FIBER FLAX FOR OREGON IN 1932-34, PRODUCED ON DIFFERENT SOIL SERIES AFTER VARIOUS CROPS BY FARMERS WHO GREW FLAX FOR THE STATE FLAX INDUSTRY.

Types of soils and crop series	Yield per acre			1932-34 Average
	1932	1933	1934	
	Pounds	*Pounds*	*Pounds*	*Pounds*
Chehalis Soils				
Flax after corn	3,887	4,668	4,890	4,482
Flax after clover	3,667	4,430	5,023	4,373
Flax after grain	-------	5,726	4,332	-------
Flax after all crops	3,514	4,224	4,721	4,153
Willamette Soils				
Flax after corn	2,567	4,354	4,537	3,819
Flax after clover	3,057	4,062	4,295	3,805
Flax after grain	-------	2,964	3,641	-------
Flax after all crops	3,009	3,693	3,964	3,555
Amity Soils				
Flax after corn	-------	-------	3,900	-------
Flax after clover	2,885	3,853	4,075	3,604
Flax after grain	1,180	-------	3,617	-------
Flax after all crops	2,633	3,965	4,028	3,542

A cultivated crop has the advantage of reducing weeds that may be present. Suggested rotations for fiber flax are:

FIRST—	SECOND—
Cultivated crop such as corn	Cultivated crop
Flax	Grain
Wheat or fall barley seeded to clover the following spring.	Legume such as clover
Clover	Flax

It has been very popular in Oregon to plant fiber flax on clover sod land, and this has been largely encouraged by flax company field men who have asked for such land. It seems to be the general opinion that clover sod land allows earlier working, plowing, and preparation in the spring months than cultivated soils.

Fertilizer value is doubtful. Although commercial fertilizers are commonly recommended and applied in the production of fiber flax in European countries, it is not believed that they are so necessary for unirrigated Oregon soils. If the soil is so poor that commercial fertilizers are necessary to produce a crop in Oregon, it is doubtful if the land should be planted to fiber flax.

Results from fertilizer experiments in the Willamette Valley have indicated that possibly an additional half ton of unthreshed flax straw per acre can be produced with the application of commercial fertilizers. Unless one considers the residual value of the fertilizer the second year, the amount of money received from the sale of the additional half ton of unthreshed straw is consumed by the cost of the fertilizer, its application, and the extra cost of pulling and delivering the half ton of fiber flax.

Further fertilizer experimental work may help show that fertilized flax has a greater value in producing a fiber of higher quality. If these results are obtained, fiber flax from fertilized fields may command a premium.

The application of barnyard manure is recommended for the crops that precede fiber flax in the rotation but *not* immediately preceding fiber flax. One reason for this is that barnyard manure usually contains numer-

ous weed seeds and weeds are not desirable in a fiber flax crop. Further, a uniform growth of all fiber flax plants is desired and barnyard manure is not often distributed uniformly enough the first year to affect all plants alike. An application for the crop preceding the fiber flax will allow the flax to acquire maximum residual benefits.

An application of lime should not precede a fiber flax crop because it is believed to be injurious to the flax fiber. Lime should be applied to other crops grown on land that is acid, thus benefiting the crops. Flax should be seeded in the rotation several years later.

PREPARATION FOR SEEDING

Planting date very important. Next to the selection of the soil no other factor in Oregon is so important to the success of the fiber flax crop as the time of seeding. This factor is important in other flax growing countries or sections of the United States where fiber flax is grown, but not to such a large extent as in Oregon.

Fiber flax must be sown before April 15 so it may receive the benefit of spring rains and obtain its greatest growth before flowering and the start of the warm dry summer period. Flax sown in May seldom attains any growth of commercial value because it hardly emerges through the soil before the dry period, thus providing little opportunity for growth. Another important reason for seeding fiber flax early is that the crop must be a success to the manufacturer, therefore it must be of fine quality and have a high percentage of fiber. Flax sown late in the spring actually has a lower percentage of fiber in the straw and is of poorer quality.

Fiber flax seed if sown early reaches maturity before there is great danger of flax diseases developing that require a high temperature. Resistance to frost injury varies according to the age of the flax. Severe frosts have been observed to injure the flax seed immediately after seeding and when it is germinating, but if the seed has germinated and the plants have emerged above the ground, they will withstand temperatures as low as 26° F. without much injury. Injury occurs very rapidly below this temperature. Seed weak in germination is greatly affected by frost injury, but usually the Oregon seed is strong in this regard.

Preparation of the seed bed. Early seeding has been stressed as beneficial to the yield of fiber flax, but it is not meant, however, to suggest that the field should be worked when exceptionally wet or to "mud in" the seed as some farmers speak of it. If the soil is not ready for the early preparation of a seed bed, it is believed that some other crop should be sown on the field at a later date when the land may be worked to best advantage. It would be better to work the soil and get a good crop of corn, potatoes, or some other crop, than to sow fiber flax under unfavorable conditions. Fall plowing is recommended in most regions where fiber flax is grown. In Oregon the heavy winter rains are likely to pack the heavier clay or silty clay soils and under such conditions it is believed late winter or spring plowing is more satisfactory.

Land should be disked and harrowed to prepare a well pulverized seed bed. The amount of working naturally will depend upon the type of soil and the conditions at the time the soil is worked. Allow the seed bed to settle following preparation and then seed immediately. Weedy fields

should be sown to some other crop that would not be injured by the weeds or late seeding. Only fertile fields free of weeds at planting time should be used for fiber flax.

Table 2. YIELDS OF UNTHRESHED STRAW PRODUCED IN SPRING- AND FALL-PLOWED FIELDS IN OREGON, 1932-34.

Soil Series	Acreage		Number of farms		Yield per acre	
	Fall	Spring	Fall	Spring	Fall	Spring
	Acres	*Acres*			*Pounds*	*Pounds*
All Series						
1932	107	480	12	70	2,534	2,916
1933	119	223	11	25	3,727	4,258
1934	436	1,176	43	148	3,968	4,251
Average yields	------	------	----	----	3,410	3,808
Willamette						
1932	11	45	2	9	2,712	3,118
1933	62	20	5	4	3,900	4,243
1934	55	279	8	38	4,516	4,296
Average yields	------	------	----	----	3,709	3,886
Amity						
1932	34	254	4	38	2,080	2,804
1933	50	79	5	7	3,956	4,048
1934	179	324	20	39	4,058	4,035
Average yields	------	------	----	----	3,365	3,629

Minimum rate 80 pounds per acre. The common rate of seeding fiber flax is 84 pounds of seed per acre. It is not advisable to seed less than 80 pounds per acre but occasionally on fertile, river bottom soils, flax will do well when seeded at the rate of 90 to 95 pounds per acre. Heavier rates of seeding are uneconomical because thick stands of flax with stems crowded and very fine in diameter, permit only a short growth.

Broadcast seeding proves popular. From studies that have been made it has been learned that many farmers sow their fiber flax with drills, allowing the seed to scatter itself broadcast on top of the soil. This method of broadcast seeding usually is followed by either dragging the soil as lightly as possible with a harrow or possibly rolling the land with a corrugated roller or cultipacker. Good results have been obtained by each of these methods.

In some cases farmers have not covered the seed at all, and when seeding is followed by an early rain to beat the seed into the ground, results have been satisfactory. If the seed is broadcast and uncovered it is not likely to germinate if a dry period follows. To hasten and cheapen the cost of operation it is suggested that farmers attach a chain or a light plank float behind the grain drill thereby covering the seed when it is broadcast.

Seed must not be covered deeply. Drilling flax seed into the ground gives good results in Oregon and elsewhere if the seed bed is reasonably firm so the seed will not be covered too deeply. Seed should never be covered more than an inch and for best results from one-quarter to one-half inch. Seed covered an inch deep or deeper probably will never reach the surface if a crust forms on the ground. The seed covered lightly may germinate and grow in a dry period, whereas the seed on the top of the ground

may fail to germinate. Properly drilled seed frequently germinates more uniformly than when broadcast. If seeding is rather late it is very important that the seed bed be well settled and firm prior to drilling the seed because loose seed beds often cause plantings to be made too deeply.

Flax germinates quickly in warm weather. Flax seed will germinate very quickly in warm weather but during the early spring months in Oregon germination is slow and may take two or three weeks before the plant appears above the ground. If heavy rains cause a crust to form upon the surface of the ground, the flax may be aided in breaking the crust by rolling the field if the work is done before the crop is more than five inches tall. As a general rule rolling will not be necessary.

Flax plants grow slowly for several weeks until they are about 12 inches tall. From this point they are likely to grow rapidly, adding as much as an inch a day to their height if weather conditions are favorable. During the rapid growing period flax does best if the weather is cool and moist, continuing the rapid growth as long as possible.

Fiber flax grows similarly to small cereal crops and requires no special care or cultivation until harvest time. A few big weeds such as thistle, dock and others that are likely to be troublesome in the field may be removed by pulling when the flax is three to five inches tall. During this period in the growth of the flax one may walk through the field without injuring the crop.

CURING AND HARVESTING FLAX

Field grading helps. Under the present method of growing fiber flax in Oregon the crop is inspected by a field man from the flax company just before harvest. This inspection is to advise and instruct the farmer regarding the time of harvesting, as well as to help him obtain a pulling machine or other necessary assistance for harvesting. The field man will determine the average length of the farmer's flax or the various grade percentages. The farmer should confer with the field man when the field is inspected concerning the grade of his flax and the approximate amount of dockage that is likely to occur from foreign material such as weeds.

Fiber flax harvested by pulling. When fiber flax is produced for spinning fiber the crop is pulled rather than cut. There are several reasons for preferring the pulled flax. The farmer usually sells his flax for so much per ton and, therefore, should be more interested in having it pulled than cut unless he receives a higher price per ton for the cut product. When fiber flax is cut and only a three-inch stubble is left, the yield of flax is reduced approximately 600 pounds per acre. Usually this additional weight will nearly pay for the pulling.

Oregon farmers should plan to pull their flax earlier than is ordinarily the practice. Pulling machine operators do not like to pull flax before it is fully ripe because they complain that the gum present in the plant interferes with the pulling operation. An effort should be made, however, to overcome this condition as far as possible because the earliest pulled flax gives the softest and finest fiber. Pulling should start when approximately one-third to one-half of the seed bolls are ripe with fully developed seed. Usually at this time the leaves have fallen off the stem for a distance of one-half the height above the ground.

Pulling charge on ton basis. During the last few years the customary charge for pulling flax has been so much per ton. This plan seems to be a much more satisfactory basis for the farmer and should be encouraged. A few years ago it was customary for pulling machines to charge a definite price per acre regardless of the tonnage of flax to be pulled per acre. Pulling charges have been materially reduced during th past ten years because

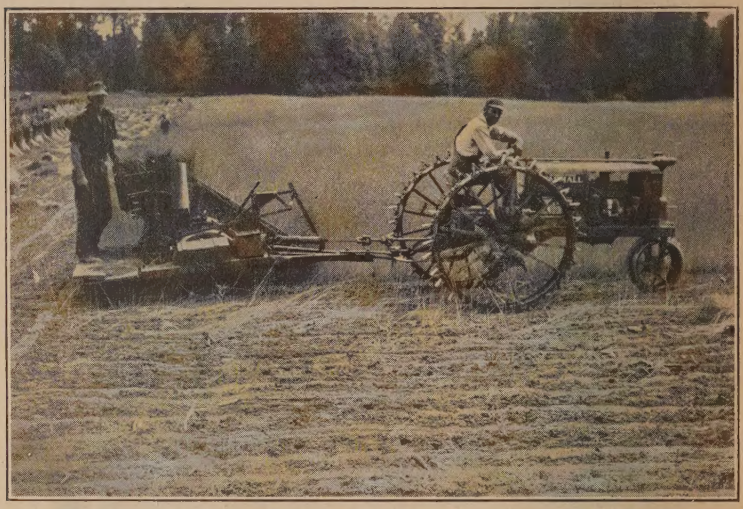

Figure 1. Flax pulling machines harvest Oregon's fiber flax economically. A machine will pull approximately five acres of flax in a day.

pulling machines have been improved and reduced to half of their original cost, resulting in more efficient operation and an increased number of tons pulled per day. Before a flax pulling machine begins to work in a field it is advisable to pull a narrow swath around the field by hand. If the field is large this may involve considerable time and additional expense to the farmer. A few farmers in Oregon have planted a narrow swath of oats around the edge of the field and the flax pulling machine runs over the oats in pulling the first swath of flax. The oats are cut later and used for hay.

Weeds must be removed. If weeds are present to any great extent in the flax they must be removed at the time of harvesting. The field man who inspects and grades the flax probably will suggest that it is necessary to have weeders at the time of pulling. The men who do this weeding follow the pulling machine around the field, removing the weeds along the edge of the next swath and therefore no flax is trampled down. It is much more economical, however, to grow fiber flax on ground free of weeds than to pay the expense of pulling them at harvest time. If the weeds are very numerous it is impossible to remove them all by hand pulling. The flax likely will be rejected by the retting and scutching mill and therefore must be threshed on the farm.

Bundles are retied. Flax is shocked in the field to allow it to cure and dry. During this curing and drying the flax straw shrinks and the strings become loose on the bundles. It is customary at present in Oregon to have the farmers retie several bundles together so they will remain intact and not fall apart in the handling necessary when hauling to the mill. When the flax straw is cured and retied, it is ready for hauling to the flax mill.

Figure 2. A shocked field of machine-pulled fiber flax grown on Chehalis soil. The flax is cured in the shock and then sold to a flax retting and scutching mill.

Oregon yields have increased. Yield figures obtained from the State Flax Industry show that the average production per acre of unthreshed fiber flax straw in Oregon during the past ten years has been 3,490 pounds or one and three-fourths tons per acre. These figures included all the flax delivered each year. During the past two years the state has insisted on

Table 3. STATISTICS OBTAINED FROM THE STATE FLAX INDUSTRY, SALEM, OREGON, SHOWING THE YIELD OF UNTHRESHED STRAW DELIVERED IN SALEM, 1925-34.

Year	Acreage	Total yield	Yield per acre
	Acres	*Tons*	*Tons*
1925	2,100	2,654.3	1.26
1926	1,644	2,376.0	1.44
1927	2,100	3,803.4	1.81
1928	2,782	3,804.8	1.37
1929	3,462	5,948.9	1.72
1930	3,811	8,740.9	2.29
1931	1,793	3,018.1	1.68
1932	713	1,091.3	1.46
1933	461	939.7	2.04
1934	1,904	3,880.6	2.04
Ten-year total	20,770	36,258.0	1.745*

*3,490 pounds per acre.

early planting and the average yield has been increased to two tons per acre. Three tons of flax per acre is an exceptionally high yield and seldom obtained. Soil not adapted to flax production is not likely to yield more than one ton per acre. Approximately five bushels of seed are obtained from threshing each ton of flax. In the earlier years a great deal of cut flax that was too poor for spinning fiber purposes and manufactured into upholstery tow was included in the above average.

FLAX MILL OPERATIONS

After the farmer has delivered his flax straw to the mill his work in its production is ended. It is not the purpose of this bulletin, and space is not sufficient, to allow a discussion of the various factory processes except to mention a few things that have some bearing on the farmer's production problems.

Threshing is first operation. In the mill the flax is first threshed and then the straw is submerged in water to allow a bacterial action to loosen the fiber from the straw. This process is called *retting.* The straw is taken from the water, dried, and later passed through machines that break the straw and remove the wood by a beating action called *scutching.* The fiber is then sorted and sold to the spinning mills for spinning into thread and twine which may be woven into linen material.

Straight straw important. In the first few operations of handling the flax straw it is important to keep it as nearly straight as possible. This simplifies and facilitates the ease of handling the straw in several of the operations. This is the reason why farmers are instructed to keep the straw tightly bound together with the butts even. In the milling operations different types of straw respond very differently in their preparation into fiber. Short straw that is very fine in diameter, called "hair flax" or "wire flax" and usually the result of sowing too thick or produced in dead furrows, is very difficult to process because the wood is not easily removed from the fiber. The consequent longer period for retting and hard beating action to remove the wood frequently breaks the fiber and causes heavy loss.

Straw with a diameter of approximately 1/16 to 3/32 of an inch is most satisfactory for processing. Straw with a very large diameter is largely wood with a very coarse fiber. Uniform sowing at a uniform depth insures an even growth of straw that responds similarly when processed. Short, fine flax mixed with long, coarse flax produces a poor, mixed grade of fiber.

Certain weeds when immersed in water with the flax and later broken on the flax machinery are entirely destroyed, but other weeds remain with the fiber and have to be removed by hand. Processing weeds returns no value to the mill.

Results of experiments have shown that flax planted at an early date yields a higher percentage of fiber to the mill than flax that is planted at a late date. Flax planted at an early date also yields a fiber that has a higher quality and greater value than the late planted flax. To make the mill operation as successful as possible and thus insure an industry for farmers, the flax should be planted early on weed free, adapted soils, thus returning a greater yield per acre.